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Short communication

Land planarians (Platyhelminthes) also prey on web-building spiders

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Abstract

Although spiders and land planarians constitute diverse groups of terrestrial predators, interactions between them are still unknown. Here, we describe a predatory event of a land planarian (*Choeradoplana* cf. *gladismariae*) on a web-building spider (*Helvibis longicauda*) in the Brazilian Atlantic Forest. The prey was constricted and covered with sticky mucus while remaining on its web trying to protect its egg sac. The event was observed in the middle-end afternoon at ca. 1.80 m height. Our observation broadens the scope of possible natural enemies of web-building spiders and the prey items of land planarians. It also indicates that these organisms can capture and overpower dangerous predatory arthropods, suggesting that even complex three-dimensional sticky webs can be ineffective against the attack of land planarians. Finally, we also show that land planarians can exhibit a flexible foraging strategy, exploiting the environment during the day and at higher heights from the ground. Our observation opens new possibilities involving focal observations and experiments using spiders and land planarians as models in predator-prey research.

Key words: Araneae, Atlantic Forest, Geoplaninae, predation

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With 50,735 species described so far, spiders are the most diversified group of terrestrial predators (World Spider Catalog 2022), playing important top-down effects in natural and human-disturbed environments (Nyffeler and Birkhofer 2017; Michalko et al. 2019). However, as spiders constitute abundant and energy-rich organisms, they are also preyed on by a wide range of natural enemies. These include several vertebrates (e.g., fish, frogs, birds, reptiles, and mammals), and invertebrates such as wasps, ants, mantids, centipedes, scorpions, solpugids, and other co- and heterospecific spiders (Wise 1995; Foelix 2011; Pérez-Miles and Perafán 2017). Nevertheless, some species-rich groups of invertebrate predators have never been reported directly attacking and consuming spiders. For instance, these include land planarians (Platyhelminthes), a speciose group with more than 960 species distributed especially in tropical moist terrestrial areas (Winsor et al. 2004; Carbayo et al. 2013; Lago-Barcia et al. 2020).

Herein, we describe the first case of predation of a web-building spider by a land planarian. The observation was made on 19 February 2014 along the margins of the Mirante river in the Brazilian Atlantic Forest located in the Intervales State Park, São Paulo state, Brazil (24°16'S, 48°25'W; Fig. 1A; see more details in Cardoso et al. 2018). The predation event was observed in the middle-end afternoon when inspecting a web of *Helvibis longicauda* Keyserling, 1891 (Theridiidae), a small spider species (female average weight = 2.9 mg, n = 240) that builds three-dimensional webs underneath broad leaves (Gonzaga et al. 2006; Cardoso and Gonzaga 2021; Fig. 1B, C). We found a land planarian *Choeradoplana* cf. *gladismariae* Carbayo & Froehlich, 2012 (Tricladida: Geoplaninae; Fig. 1F; identified based on external morphology) constricting and covering with sticky mucus a female *H. longicauda* in a web located on the riverbank at approximately 1.80 m from the ground. The spider was still alive and trying to protect its egg sac by grabbing it with the legs (similar to Fig. 1C). We took both individuals to the research base to take photographs. After approximately one hour of transport, the spider was less active but still attached to the egg sac. The land planarian was constricting the spider and apparently inserting the pharynx and preying on it (Fig. 1D, E). We did not observe it preying on the egg sac.

While some land planarians have a diet specialized in soft-bodied prey, such as earthworms, other species are more generalist and can prey on many organisms (Boll et al. 2015, 2020; Boll and Leal-Zanchet 2016, 2018a, b). These include arthropods which demand a wide range of predatory behaviors to intercept, then perforate the exoskeleton and secrete digestive fluids (Dindal 1970; Ogren 1995; Winsor et al. 2004; Silva et al. 2018; Cuevas-Caballé et al. 2019). However, interactions of land planarians with their prey are difficult to observe in nature due to their furtive habits, and most knowledge has been gathered based on laboratory essays (Ogren 1995; Boll et al. 2015, 2020; Boll and Leal-Zanchet 2016, 2018a, b; Cuevas-Caballé et al. 2019). Cuevas-Caballé et al. (2019) performed the DNA sequencing of the intestinal content of *Cephaloflexa bergi* (Geoplanidae) and demonstrated how the diet of a land planarian can be diverse. They found that its diet includes other land planarians, woodlice (Isopoda), pygmy grasshoppers (Tetrigidae), lepidopterans, hymenopterans, harvestmen (Gonyleptidae) (see also Silva et al. 2018), and even spiders of the family Sparassidae (genus *Caayguara*) (see also Winsor et al. 2004 for a list on prey items). These spiders do not build webs and are known to be fast and active wandering spiders (Jocqué and Dippenaar-Schoeman 2007; Rheims 2010). Since some planarians are also scavengers (Winsor et al. 2004; Boll et al. 2015; Gerlach 2019), it is possible that the spider reported by Cuevas-Caballé et al. (2019) was not actively captured by the land planarian. In addition, Jones et al. (2020) reported *Caenoplana variegata* (Geoplanidae) feeding on an unidentified spider. We cannot ensure that the land planarian captured the spider in this case since it could also be acting as a scavenger.

Alternatively, Gonzaga and Leiner (2013) showed that *H. longicauda* females are aggressive towards their prey and on approaching infanticidal males. Predation pressure on offspring leads females to maintain a long period of maternal care for egg sacs and spiderlings. When resting on their webs, females remain close to the egg sac, continuously touching its surface and rarely moving away. This behavior leads us to suggest that the female *H. longicauda* we observed was probably overpowered because it stood close to the eggs instead of running away. Interestingly, the land planarian did not get stuck in the web of

Figure 1. (**A**) Mirante river and respective margins where the predation event was observed, located in the Brazilian Atlantic Forest, Intervales State Park, São Paulo state, Brazil. (**B**) Structure of the three-dimensional web of *Helvibis longicauda* and (**C**) an adult female resting on the web while protecting its egg sac. (**D, E**) *Choeradoplana* cf. *gladismariae* preying on *H. longicauda*, which is still trying to protect the egg sac while being constricted and covered with sticky mucus. (**F**) Detail of *C.* cf. *gladismariae* after being purposely separated from the spider for photography.

H. longicauda, which is highly adhesive due to the presence of viscid silk lines and droplets (Gonzaga et al. 2006). We suggest that the mucus secreted by land planarians prevents the adhesion of viscous threads, allowing their movements on the abaxial surface of the leaf used to support the web.

As an adaptive response to their sensitivity to environmental variations in temperature and humidity, land planarians are usually nocturnal, hiding themselves during the day underneath rocks, rotting logs, or leaf litter (Dendy 1889; Kawaguti 1932; Froehlich 1955; Ogren 1956; Kaneda et al. 1990). However, the predation event reported herein was observed during the day, an unusual period even to visualize these animals. At the margins of the river where we observed the event, the temperature is mild during the day (mean ± SD = 19.43 ± 0.58 °C, n = 5 sampled points) and the relative humidity is high (94.20 ± 1.30%) (Cardoso 2020). The time we observed the event indicates that land planarians can forage in distinct periods in environments with appropriate conditions, such as in riverbanks. There are some reports of land planarian activity during daylight (Froehlich 1955; Thielicke and Sluys 2019). In addition, land planarians are known to hunt on prey that usually share the same ground-level habitat (Ogren 1995; Winsor et al. 2004). Interestingly, the predation event happened at almost 2 m high. In March 2001, this same species was also observed during the day up on a tree at 2 m height in the garden of the Parque de Ciência e Tecnologia of the University of São Paulo (USP), in São Paulo state, Brazil (Marcos Hara, pers. comm.). This shows that land planarians can move through considerable vertical distances when foraging.

We have broadened the scope of possible natural enemies of web-building spiders by reporting a new item included in the diet of land planarians. This indicates that these animals can capture and overpower predatory arthropods representing potential risks of injury and death. Most remarkably, it suggests that even complex three-dimensional sticky webs can be ineffective against the

attack by *C.* cf. *gladismariae*. We also showed that land planarians can exhibit a flexible foraging strategy, exploiting the environment during the day and at higher heights from the ground than presupposed. Our observation opens new possibilities involving focal observations and experiments using spiders and land planarians as model taxa in predator-prey research.

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Additional information

Conflict of interest

No conflict of interest was declared.

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Author contributions

All authors contributed to the writing and review processes.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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